PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF	:	John Grassi et al.
FOR	:	**MOLD-REMOVAL CASTING METHOD AND APPARATUS**
SERIAL NO.	:	10/614,601
FILED	:	July 7, 2003
EXAMINER	:	Ing Hour Lin
ART UNIT	:	1725
CONFIRMATION NO.	:	7816
ATTORNEY DOCKET NO.	:	**GISZ 2 00031**

DECLARATION UNDER 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

The undersigned declares as follows:

1. My name is John Campbell. I hold the post of Emeritus Professor at the University of Birmingham, UK. Previously, for the past 15 years I have been the Professor Casting Technology at the University of Birmingham, UK.

2. I am author of the casting textbooks "Castings 2nd Edition" 2003 and "Castings Practice" 2004 published by Butterworth Heinemann, Oxford, UK. These books are being adopted world wide for the training and education of casting personnel. I am contracted to produce a further book, currently in preparation, "Casting Processes" in which all the world's casting processes are critically reviewed.

3. Prior to my time as Professor at the University of Birmingham, I was for 7 years Technical Director of Triplex Alloys Limited, a foundry operation in the UK that produced aluminum, bronze and iron castings. Prior to this I was for 7 years Director of Cosworth R&D Limited, an aluminum casting operation producing automotive

components for racing and high performance engines. I hold consultancies with many of the world's largest casting operations.

4. Overall, I have published approximately 150 papers on liquid metals, solidification, and casting technology. I am also listed as an inventor on about 20 patents. I am also one of the inventors of the instant patent application.

5. Among other professional activities, I am a Fellow of the Royal Academy of Engineering; and The Institute of Cast Metal Engineers. Also, I am the European Editor of the International Journal of Cast Metals Research.

6. In one aspect, the instant application pertains to a process for casting metals. The process is succinctly and accurately described in the patent application, and comprises the steps of:

"providing a mold;

delivering a molten metal into the mold;

solidifying the molten metal; and,

removing at least a portion of the mold, wherein the step of removing the mold begins before the step of solidifying the molten metal has been completed."

7. Put another way, the process can be stated as, "a process for the casting of metals comprising the steps of:

"providing a mold;

supplying molten metal to the mold;

spraying the mold with a solvent;

decomposing at least a portion of the mold with the solvent; and,

cooling the molten metal with the solvent, wherein the step of spraying commences before the molten metal has completely solidified."

8. In one embodiment, the solvent includes water and the molten metal includes aluminum. It is truly surprising that such a process does not lead to explosions, as the oxygen in water reacts violently with molten aluminum.

9. In my view, the subject matter disclosed in U.S. Application Serial No. 10/614,601 is the most novel and revolutionary development I have ever witnessed in the casting industry. It may well be the most important process invention in the casting industry in the last several decades, perhaps centuries.

10. The process appears simple, but is entirely surprising and counter-intuitive. It involves a step forbidden by conventional thinking and time-honored practice within the industry, namely, directing water onto the mould, thus removing at least a portion of the mould, whilst the metal within it is still at least partially molten. One benefit of the removal of the mold by the water prior to the complete solidification of the casting is that it allows the water to impact the casting directly at the earliest possible moment. In this way the insulating effect of the presence of the mold is removed, with the consequence that the rate of heat extraction is at a uniquely high level. The rate of freezing of the casting is thereby enhanced to a level high above all alternative casting techniques using aggregate molds, with corresponding significant benefits to productivity, and the integrity and properties of the casting. In addition, the completion of the removal of the mold, together with the uniquely severe cooling effect mentioned above, soon after the casting is poured means that the casting is clean and cold, ready for further processing almost immediately after pouring. This is a welcome and surprising benefit that cannot be offered by other casting processes."

11. Not only is the process itself amazing in its simplicity and novelty, the castings that are produced are also uniquely benefited by the extremely rapid cooling (naturally much faster than any other shaped casting process because of the direct contact of the cooling water with the casting).

12. Methods of casting such as the one described in U.S. Patent No. 2,968,848 to Carter are known. However, in this method of casting, the molten metal solidifies completely before the mold is removed. More particularly, the Carter specification states that the shell mold 20 is immersed in the molten metal bath 22 "until the molten metal therein solidifies and preferably for some interval of time thereafter" as this "is important in the practice of the invention" (see column 3, lines 48-51). Moreover, Carter explicitly teaches against the use of water during the molding process. He states in particular that water does not afford oxidation protection to ferrous alloys, owing to the unavoidable generation of steam (see column 3, lines 70-72). Thus, despite the fact that high cooling rates are obtained if water were to be used, water cannot be used when employing the Carter highly gas permeable refractory shell mold.

Instead, Carter teaches the use of molten aluminum as the cooling bath for the ferrous metal.

13. Also, Carter teaches that the casting is cooled through the mold. In other words, there is no teaching in Carter that the mold is removed in order to solidify the molten metal into the casting. In this connection, Carter particularly notes that the liquid used as a coolant "acts essentially to conduct heat away from the mold and establish a controlled cooling rate" (see column 2, line 61-63). Thus, solidification and cooling of the molten metal in Carter takes place through the mold. The mold is not removed during the process of solidifying the molten metal into a casting.

14. Water dispersible molds, such as molds of the type illustrated in U.S. Patent No. 5,641,015 to Challand are also known. In Challand, foundry sand and a binder which includes polyphosphate chains and/or borate ions is combined with at least one fine particulate refractory material. Challand teaches that the fine particulate refractory results in improvements in the strength of the mold when it is hot, prior to casting. With these types of molds, the mold is not removed until after the cast metal is completely solidified. Challand particularly notes that removal of the mold after casting can be carried out by soaking the casting in a water bath and then flushing the casting with water (column 9, lines 45-47). Completely solidifying the cast metal before removal of the mold is assumed in Challand and is, of course, standard practice in the industry. In fact, I do not know of any casting process currently in use, in which the mold is removed before the cast metal in the mold has completely solidified. In fact, it would be difficult for anyone skilled in the art of casting to imagine that a liquid metal could be held in a mold that was in the process of disappearing. It becomes even more shocking to those skilled in the art, when it is realized that the act of disappearance is effected by the action of water (of all materials, the most dangerous and most forbidden) directly onto the casting.

15. An investment composition of the type disclosed in the Pineda 6,551,396 patent is also known. Pineda particularly teaches that only by using the specified components, in the specified amounts, can one obtain the right balance of gas permeability, set time and other properties (see column 3, lines 34-36). In Pineda, mono-ammonium phosphate, magnesium oxide and silica filler are the only materials

utilized, since other ingredients added to this mixture can have an adverse impact on gas permeability and/or setting time and/or cast softness and smoothness (see column 5, lines 17-22). In Pineda, the mold that is made is then used to produce a casting. The mold is then allowed to cool and subsequently removed by grinding, sand blasting or other means, such as dropping the mold into water to create a heat differential between the inner and outer surfaces of the mold to crack the mold (see column 6, lines 24-31). What is important is that the mold is allowed to cool before the casting is removed. Thus, the casting has completely solidified before the mold is removed in Pineda.

16. In my view, there would be no reason to combine Carter with Challand and Pineda, as the three patents teach completely different types of molds. But, even if the Challand water dispersible mold were used to replace the thin walled shell mold taught in Carter, and if the molten aluminum in bath 22 were replaced with water, and if the Pineda concept of removing or cracking the mold were utilized, there is no teaching or disclosure in any of these three patents of removing at least a portion of the mold before the molten metal has completely solidified into a casting.

17. Even if the disclosure of Sahari 5,158,130 or Conroy 5,915,452 were added to the teachings of Carter, Challand and Pineda, this combination of patents does not teach or disclose a method of casting in which mold removal begins before the molten metal has completely solidified into a casting. In this connection, Sahari teaches that after the cast metal or metal alloy has crystallized, then the mold and any core can be disassembled (see column 6, lines 11-12). Similarly, in Conroy, the teaching is to the removal of ceramic cores from turbine blade investment castings (see column 3, lines 24-26). Neither of these patents contemplate that one could remove at least a portion of the mold before the molten metal has completely solidified into a casting.

18. Therefore, it is my opinion based on decades of work in casting technology that the subject matter disclosed in the instant application is novel and not obvious in view of Carter, Challand, Pineda, Sahari, Conroy, or any of the other cited references.

19. Another feature of the disclosure in the instant application is that the casting can be directionally solidified in the mold, while the mold is being removed. Still

another feature is that while the casting is solidifying, and as the mold is removed, molten metal continues to be fed to the casting. This makes for a much sounder casting. Neither of these features is disclosed in the patents mentioned above.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that wilful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,

By _____

Printed Name: John Campbell

Date: 16 July 2005

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

The undersigned declares as follows:

1. My name is John Campbell and I hold the post of Emeritus Professor at the University of Birmingham, UK. I am also a co-inventor of the instant application. The purpose for this declaration is to supplement my earlier declaration dated 16 July 2005.

2. In the Office Action of 7 February 2006, claim 1 of the application was rejected as being unpatentable over a Japanese Patent Document JP 59156566 in view of a U.S. Patent to Kawaguchi et al, U.S. Patent No. 4,971,134.

3. Claim 1 of the application now recites a process for the casting of metal which includes providing a mold including an aggregate and removing at least a portion of the mold including at least a portion of the aggregate, wherein the step of removing the mold begins before the step of solidifying the molten metal has been completed.

4. The Kawaguchi patent shows a metal mold, as is evident from, e.g., the cross sectional views in numerous figures, for example, Figures 35-38. Also, Kawaguchi states that the mold 1 is formed from a copper chromium alloy (see column 10, lines 11-13 and column 13, lines 8-9). The mold 1 is constructed of a first die 1_1 and a second die 1_2 into a split type and is opened and closed by an operating device (see column 10, lines 14-16).

5. The Japanese '566 document also appears to show a metal mold. This is evident from Figure 5 of the drawings, where a cross-section of the mold is shown. The drawing symbol used in Figure 5 is for metal.

6. In the case of metal molds, such as those shown in Kawaguchi and the Japanese '566 document, including such mold types referred to as "permanent molds" and "dies for die casting processes" etc., it is common for the mold to be opened prior to the complete solidification of the casting. This is widely known, perfectly well understood and practiced in permanent mold foundries and die casting shops all over the world. Therefore, the disclosure of such a mold in the Kawaguchi patent is not remarkable.

7. In many cases, the early opening of the mold is necessary to achieve better productivity for a casting. In the case of die casting, such early opening will, if carried out with excessive zeal, cause the entrapped air in still molten regions of the casting to expand, with the result that the casting distorts or blisters and, in extreme cases, explodes. When such cases are experienced, the foundry will, with reluctance because of loss of productivity, extend time in the mold to further build up the solidified shell to reduce these problems.

8. I am unaware of any method for removing the mold while the casting is still at least partially molten in the case of aggregate molds. Such a practice would probably be dangerous. This is because the lower temperature gradient as a result of the less severe cooling does not build up such an effective solidified shell. In fact, for many alloys, particularly many non-ferrous base alloys that have high thermal conductivity, the temperature gradient in the casting is so low that liquid can remain at the casting surface until the final moments of solidification.

9. It follows, therefore, that it would be unthinkable for the mold to be removed prematurely, prior to complete solidification, and especially with water. Such an action would be unthinkably dangerous. Such danger is fundamental to the thinking of foundry personnel throughout the world. All casting education focuses on the extreme danger of mixing molten metal and water.

10. The Sahari and Conroy patents were discussed in my earlier declaration at paragraph 17. Therefore, they will not be further addressed in this declaration.

11. Claim 16 is to a process for reducing the cooling time of a metal that has been cast. It includes decomposing at least a portion of the mold with a solvent via spraying and cooling the molten metal with the solvent wherein the step of spraying commences before the molten metal has completely solidified. No such decomposition of the molds is seen in the metal molds of Kawaguchi and the Japanese '566 patent. Nor is there such a decomposition in Sahari or Conroy.

12. Claim 47 recites a process for casting an aluminum metal, including decomposing at least a portion of the mold at an elevated temperature with a solvent including water wherein the step of decomposing at least a portion of the mold begins before the molten aluminum metal has completely solidified into a casting. No such decomposition of a mold is shown in any of the patent documents to Kawaguchi, Japanese '566, Sahari or Conroy.

13. Claim 54 recites a process for reducing a cooling time of a metal that has been cast, including percolating a solvent including water through the mold to the cast metal, forming a relatively solid skin on the cast metal while an interior thereof remains molten and subsequently contacting the relatively solid skin of the cast metal with the solvent. Of course, with a metal mold, no such percolation of the solvent through the mold can take place.

14. Claim 62 now recites a method of removing a mold including an aggregate from a casting which is being formed therein comprising directing a fluid stream at the mold when the casting is partially solidified and dislodging at least a portion of the aggregate of the mold from the casting. This method is not shown in any of the patent documents to Kawaguchi, Japanese '566, Sahari or Conroy.

15. There remains no doubt therefore, that despite molten metal being well-known, and despite water being well-known, there can be no case for it being obvious to mix them by early removal of an aggregate mold.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Respectfully submitted,

By _____

John Campbell, OBE, FREng, DEng, PhD, MMet, MA.
Professor Emeritus of Casting Technology
The University of Birmingham, UK

Date: 18 March 2006

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